DOT/FAA/DS-89/25

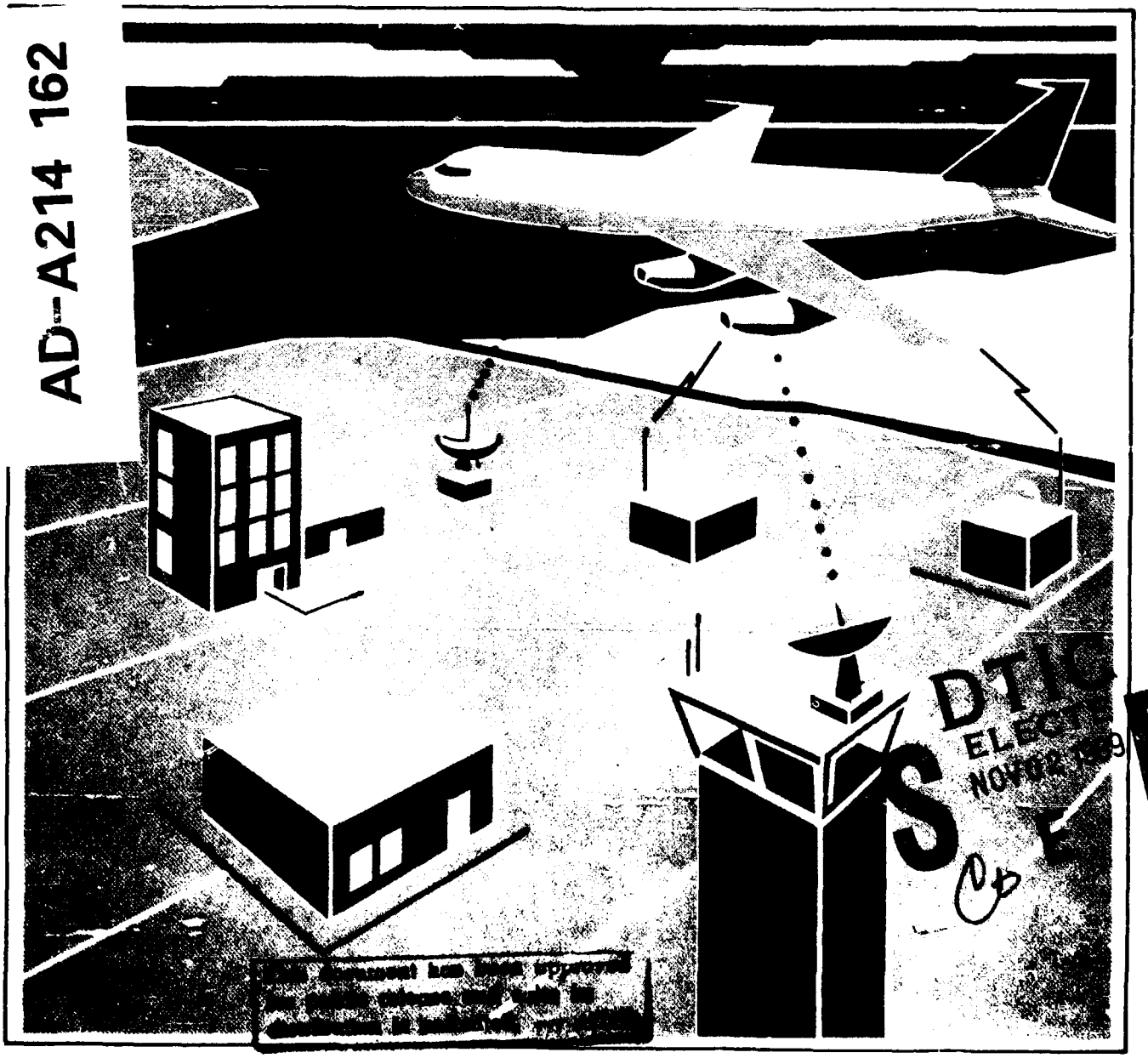
National Airspace System

Approach and Departure Sequencing Operational Concept

NAS-SR-1322

U.S. Department of Transportation

Federal Aviation Administration



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Advanced System Design Service
Washington, D.C. 20591

National Airspace System Approach and Departure Sequencing Operational Concept (NAS-SR-1322)

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16. Abstract

This concept of operations is one of many high level documents that will, in total, describe the operations of the National Airspace System (NAS) when the NAS Plan has been implemented, i.e., the "end state." These documents as a set will assist in linking the requirements specified in NAS System Requirements Specification (NASSRS) with the NAS design. One of the functions of the NAS is to support approach and departure sequencing at specific airports. The objective of this document is to describe the relationship among subsystems, facilities, information, and operators/users involved in the approach and departure sequencing function. This document is intended as a tool for system designers, analysts, and test planners. The document contains several types of block diagrams illustrating system connectivity, and operational flow. These diagrams in conjunction with the text are intended to provide perspective and insight into the NAS "Approach and Departure Sequencing" function.

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1.0 INTRODUCTION

1.1 Background

The mission of the Federal Aviation Administration (FAA) is to provide for the safe and efficient use of the nation's airways. The National Airspace System (NAS) System Requirements Specification (NASSRS), NAS-SR-1000, is a compilation of requirements which describe the operational capabilities of the NAS upon completion of the NAS Plan (end-state system). To provide efficient use of airspace, specialists must provide users with instructions which result in the establishment of landing and departure sequences at specific aerodromes. Sequencing requires the NAS to provide specialists accurate information on aircraft locations.

This operational concept document has been developed using an established standard format and is consistent in structure with a series of operational concepts written about various sections of the NASSRS.

1.2 Objective

The objective of this operational concept is to describe the functions involved in approach and departure sequencing in the NAS "end-state" system. More specifically, this paper intends to:

- Provide a common operational perspective across subsystems, operators, and users.
- Show the interrelationships between subsystems, facilities, information, and operators/users.

1.3 Scope

This document covers the Approach and Departure Sequencing as delineated in Section 3.2.2 of the NASSRS. The operations described are limited to those associated solely with approach and departure sequencing services. The paragraphs in NASSRS Section 3.2.2 and their contents are as follows:

3.2.2.A	Aircraft identification, location, altitude, course, speed, and characteristics
3.2.2.B	Voice and data communications within assigned airspace
3.2.2.C	Issuing sequencing and spacing advisories
3.2.2.D	Receiving and processing departure requests

3.2.2.E Comparing actual flight paths for deviations
3.2.2.F Providing recommendations for current runway selection
3.2.2.G Providing recommendations for future runway selection

This document considers approach sequencing from the point where the approach controller for the sector monitors the aircraft to the time the aircraft lands on the runway. This document considers departure sequencing from the point where clearance to depart is requested from the clearance delivery controller to the time that the aircraft is handed off to the sector en route controller. Thus, although the En Route Metering is not covered, programs that affect arrival and departure times are referred to as necessary.

1.4 Methodology

The methodology used to develop the operational concept provided information in a number of different ways. The material is presented using four different kinds of diagrams with associated descriptions.

1. OPERATIONAL BLOCK DIAGRAM/DESCRIPTION. The operational block diagram illustrates the connectivity between major elements of the NAS, i.e., processors, specialists/controllers, and the user for those elements that support the service. The operational block diagram in this Operational Concept is extracted from the overall NAS Operational Block Diagram. Principal features of the operational block diagram/description include the following:

   a. Each specialist/controller is indicated by a number. This number remains the same in every operational concept.

   b. Dotted lines segregate facilities.

   c. Solid lines show digital data flow. Voice data flow is not shown.

   d. The blocks within each facility are the major processors.

2. OPERATIONAL FLOW DIAGRAMS/DESCRIPTIONS. The operational flow diagram and associated description for each specialist/controller provides more detail about the inputs, processors, outputs, and interfaces for each operator. Operational flow diagrams are used

to describe functions of the products and services of individual specialists or controllers. The diagrams show major actions only. Ancillary actions such as specific requests for information on system conditions are not shown. Principal features of an operational flow diagram include the following:

a. Dotted lines segregate facilities.

b. White boxes indicate specialist, controller, or user functions. Shaded boxes indicate machines.

c. The functions listed by lower case alphabetic characters in the white and shaded boxes are explained in the text.

3. OPERATIONAL SEQUENCE DIAGRAMS/DESCRIPTIONS. The operational sequence diagram and associated descriptions shows a typical sequence of steps taken by operators or users in providing the service. Principal features of an operational sequence diagram include the following:

a. Users and specialists or controllers involved with providing or using the service are listed along the vertical axis. When required for clarity, other FAA facilities may also be listed on the vertical axis.

b. The horizontal axis represents time. Sequential events or functions performed by an operator or user are indicated within separate boxes. Events which may occur simultaneously or near-simultaneously are indicated by the same number. The numbers on the right side of the blocks refer to numbers in the text.

c. Decision points or points where alternate paths may be followed are indicated by a diamond shape.

d. Circles are connectors and indicate exit to, or entry from, another diagram. Circles with a numeric character connect either to another diagram, the relevant figure number is listed underneath if connection is to a different diagram. Further, functions within the boxes preceded by a lower case alphabetic character reference the same functions listed in the operational flow diagrams. Thus, the relationship between operator/user interactions and relevant NAS subsystems is depicted.

4. OPERATIONAL SCENARIO(S)/DESCRIPTION(S). The operational scenario and associated description depict a specific predefined situation and illustrate a particular subset of the generalized operational sequence diagrams. Principal features of operational scenario diagrams include the following:

   a. Users and specialists or controllers involved with providing the service are listed along the vertical axis.

   b. The horizontal axis represents time. Sequential events or functions performed by an operator or user are indicated within separate boxes. The numbers on the right side of the blocks refer to numbers in the text.

   c. Shaded portions of boxes represent machine actions.

1.5 Document Organization

The remainder of this document is organized as follows. Section 2 is the main body of the document and is divided into six subsections. Section 2.1 provides an operational block diagram which illustrates the connectivity between subsystems, facilities, operators, and users that are involved in approach and departure sequencing and provides an operational summary of each position. Section 2.2 describes the information required or used to provide approach and departure sequencing services. Section 2.3 expands the functions performed at each position in operational flow diagrams and provides more detail about inputs, processes, outputs, and the interface with the user. It also summarizes NAS subsystems functions. Section 2.4 correlates the NASSRS with this document. Section 2.5 presents generalized time-sequenced operator/user interactions for Area Control Facility (ACF) controllers and the Airport Traffic Control Tower (ATCT) controllers. Section 2.6 provides a scenario to illustrate a specific hypothetical situation where approach and departure sequencing services are provided.

2.0 OPERATIONS

2.1 Support

The NAS is required to support approach and departure sequencing activities, as described in Section 3.2.2 of the NASSRS. Figure 2-1, Overview of NAS/User Systems for Approach/Departure Sequencing, illustrates all the NAS facilities, systems, and user systems that support the approach and departure sequencing functions.

Approach and departure sequencing is supported by Flight Service Data Processing Systems (FSDPS), Area Control Computer Complexes (ACCC), Tower Control Computer Complexes (TCCC), Air Traffic Control (ATC) Radar Beacon Systems (ATCRBS) (Mode A, Mode C, or Mode S), ATC specialists (including controllers), and pilots.

2.1.1 NAS Facilities/Systems/Positions

The NAS facilities, systems, specialist positions, and major information paths that may be involved in approach and departure sequencing operations are shown in Figure 2-2, Approach and Departure Sequencing Operational Block Diagram. The primary purpose of the ACCC is to provide continual automated assistance to controllers within an ACF. The ACCC includes both the equipment and software required to support the control of aircraft in a volume of airspace under the air traffic jurisdiction of an ACF. The ACCC includes computers, computer software, displays, input/output devices, and controller/operator workstations. The ACCC provides controllers at an ACF with the ability to track all aircraft within the responsibility of their region. Controllers interface with the ACCC through sector suites.

The ATCT has primary responsibility for control of aircraft arriving or departing from an airport, operating within the airport traffic control area, or taxiing on the airport. The TCCC provides automation support for those controllers who work in an ATCT. A TCCC include the equipment and software that supports control of aircraft, including the airport surface, under the air traffic jurisdiction of an ATCT. This also includes control of those airport systems that are related to ATC. ACCCs and TCCCs have the same equipment and software to the extent possible.

The FSDPS is a data processing system for the Flight Service Stations (FSSs) that is used to process instrument flight rules (IFR) and visual flight rules (VFR) flight plans filed mainly by general aviation pilots. (Commercial aviation flies flight plans directly with the ACF.)

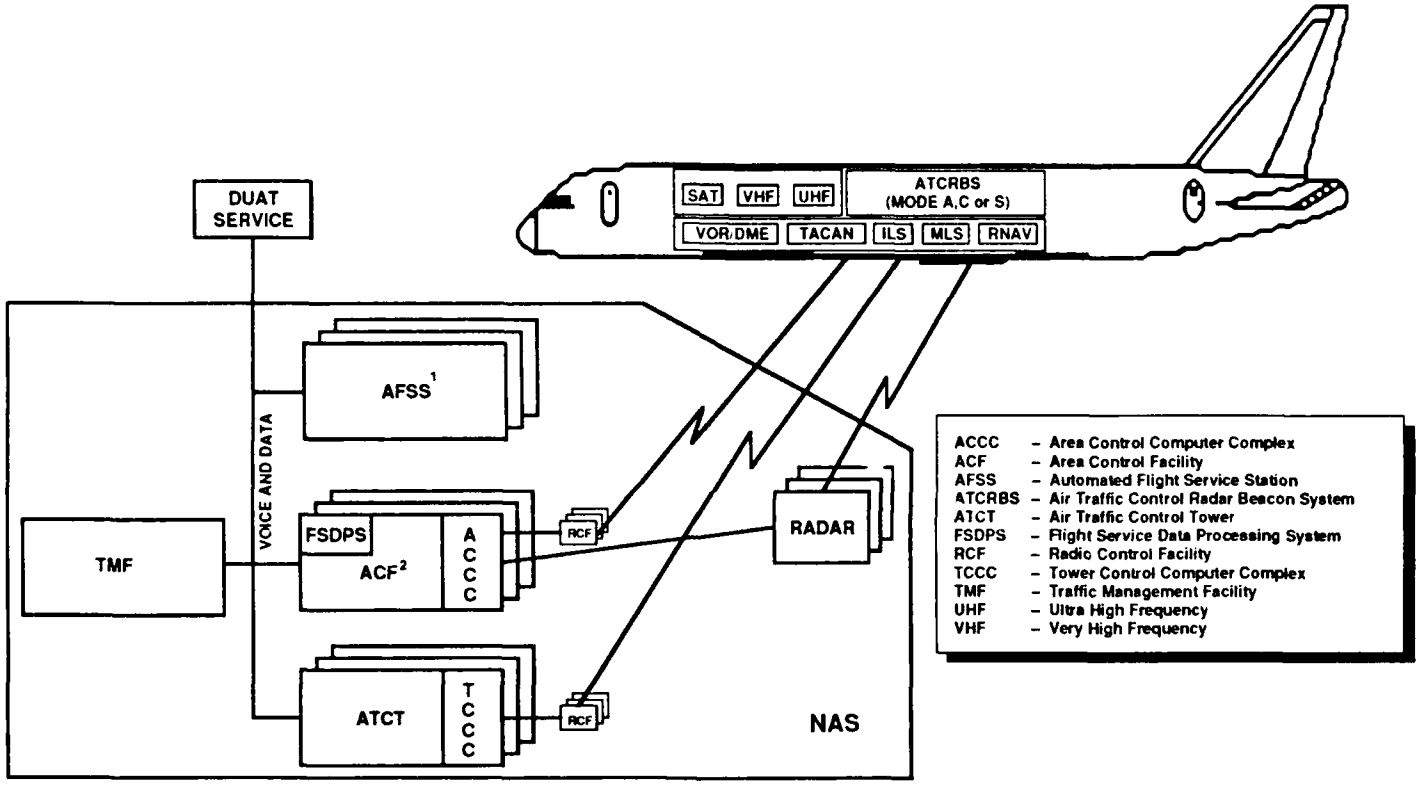

FIGURE 2-1

OVERVIEW OF NAS/USER SYSTEMS FOR APPROACH/DEPARTURE SEQUENCING

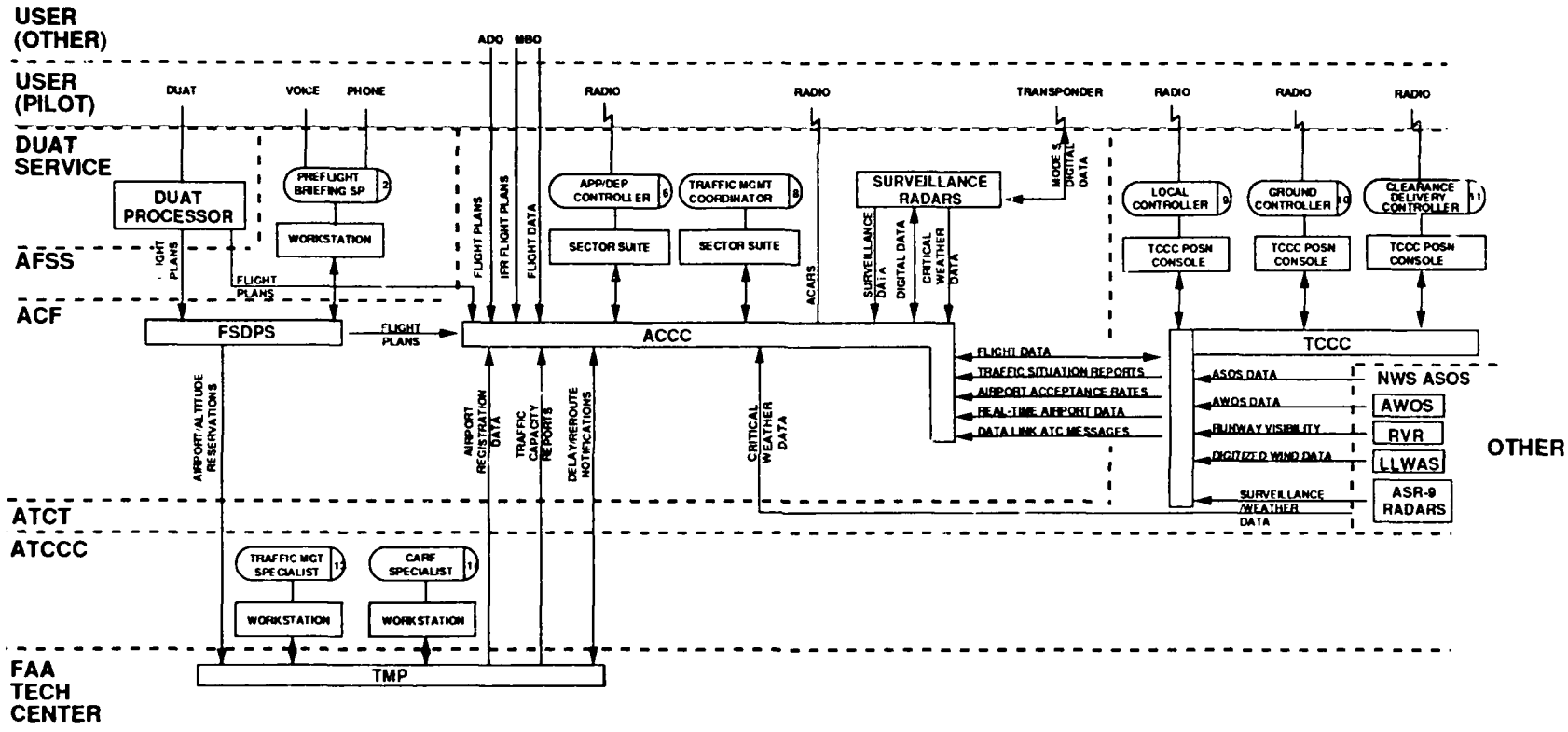

FIGURE 2-2

APPROACH AND DEPARTURE SEQUENCING
OPERATIONAL BLOCK DIAGRAM

The function provided by each specialist position and a description of each follows. Included with each description is a reference to the current procedures manual for the position and to those NAS projects that are most likely to affect how the specialist provides the service.

Position 6: Approach/Departure Controller

Function: Provides sequencing instructions to pilots on approach to and departure from an airport.

Description: The approach/departure controllers are located in the ACF. Their sequencing responsibilities involve aircraft within the terminal airspace, and include ensuring separation; issuing control instructions; monitoring radios; and accepting and initiating automated hands-off.

Procedures: FAA, "Air Traffic Control (7110.65)"; Chapter 3, Sections 5, 8, 9, and 10; Chapter 4, Sections 3, 5, and 7; Chapter 5, Sections 9 and 10; Chapter 6, Sections 2 and 3.

Projects: NAS Plan ATC En Route Systems:
Project 12, Advanced Automation System (AAS)
Project 13, Automated En Route Air Traffic Control (AERA)
Project 14, Integration of Nonradar Approach Control Into Radar Facilities
Project 15, Area Control Facilities NAS Plan ATC Terminal Systems:
Project 15, Combine Radar Approach Control into ARTCC

Position 9: Local Controller

Functions: Provide clearances and advisories to aircraft within the airport traffic area and to aircraft on (or about to be on) the active runway(s).

Description: The local controller is located in the ATCT. The local controller provides final instructions to aircraft landing at an airport, and also provides aircraft departure instructions. Local controller responsibilities can include departure and arrival spacing, sequencing, and traffic flow except when these services are provided by the approach/departure controller. The ATCT local controller's area of jurisdiction is at least the active runways, and usually the entire airport

traffic area. On departure, the ATCT local controller directs the aircraft when to contact the ACF departure controller, and thus effects transfer of control of the aircraft to the departure controller.

Procedures: Same as position 11

Projects: Same as position 11

Position 10: Ground Controller

Functions: The ground controller sequences departing aircraft for takeoff on the assigned runway.

Description: The ground controller is located in the ATCT. Ground controllers are supported by the TCCC through the TCCC Position Console (TPC).

The ground controller issues instructions to departing aircraft to direct and sequence the aircraft, according to the departure clearance time and destination, to the current takeoff runway. The ground controller then releases the aircraft to the local controller for actual departure.

For arriving aircraft, the ground controller directs aircraft to the appropriate taxiways and gates and may have to sequence aircraft if several runways are being used for landings.

Procedures: Same as position 11

Projects: Same as position 11

Position 11: Clearance Delivery Controller

Function: The clearance delivery controller issues clearances to departing aircraft.

Description: The clearance delivery controller is located in the ATCT with the local and ground controllers. The TCCC supports clearance delivery through the TCCC Position Console. When ready to depart, the pilot requests departure clearance. The clearance delivery controller receives IFR and (less frequently) VFR Flight Plan information from the TCCC. The clearance delivery controller also receives departure information from pilots who are ready to taxi once they get clearance. The controller may also receive requests from pilots to amend their previously filed flight plans.

When the flight plan or departure information is complete, the clearance delivery controller issues the aircraft a departure clearance that provides the initial sequence for departing traffic. If a clearance cannot be granted, the clearance delivery controller provides the aircraft delay information.

Procedures: FAA, "Air Traffic Control (7110.65)"; Chapter 3, Sections 1, 8, 9, and 10; Chapter 4, Section 3; Chapter 6, Section 3.

Projects: NAS Plan Air Traffic Control (ATC) Terminal Systems:
Project 12, Tower Communications Systems
Project 13, ATCT/TRACON Establishment Replacement, and Modernization
Project 15, Combine Radar Approach Control Into ARTCC

2.1.2 User Systems

The aircraft in Figure 2-1 shows supporting user systems which include the following:

- Two-way radios for voice communication which could be either VHF, UHF, satellite, or a combination;
- Data communication transcription systems which could be Mode S, satellite, VHF, or a combination;
- Surveillance transponders such as Air Traffic Control Radar Beacon System (ATCRBS) (Mode A, C, or S); and
- Navigation equipment including VOR, DME, TACAN, ILS, MLS, and RNAV such as INS.

Few, if any aircraft have all of the above systems, but most aircraft have some combination of the above systems.

2.2 Information

This section describes the information required or used in the approach and departure sequencing service processed through the NAS hardware and software systems and also information exchanged directly between the pilot and controller.

2.2.1 Information Processed Through the NAS

This subsection describes information required or used for the approach and departure sequencing service processed through NAS hardware and software systems.

ACF sector suites and TCCC position consoles display to controllers the following information for controlled aircraft within assigned airspace:

- Unique aircraft identification
- Position of controlled aircraft
- Reported altitude
- Course
- Speed
- Aircraft performance envelopes

Controllers provide the ACCC with airport acceptance rates, and specify desired sequence and time at meter fixes on approach or departure routes for airports. The ACCC generates traffic sequencing and spacing advisories in response to the above information input by controllers.

Information on significant deviations between actual flight paths of controlled aircraft in assigned airspace and the flight path assigned by the specialists is available to controllers. If the aircraft has deviated beyond specified limits from its assigned position in a lateral or vertical direction, the ACCC displays the information to the controller. Flight data for departing and approaching aircraft, traffic flow data, and various weather products are available to controllers. Specifically tower controllers require information on current local traffic flow, local inbound traffic flow, flow metering, flight plans, precipitation, winds aloft, local wind, barometric pressure, and runway surface conditions, in order to provide runway recommendations.

Much of the information processed by the ACCC and TCCC comes from bulk data entry of flight plans for commercial aircraft, from military base

operations, and from IFR and VFR pilot-submitted flight plans for general aviation. Information submitted by the pilot through an IFR Flight Plan includes the following:

- Aircraft identification
- Aircraft type, special equipment
- Computed true airspeed (TAS)
- Departure airport identifier code
- Proposed departure time
- Requested en route altitude or flight level
- Defined route of flight
- Destination airport identifier code
- Estimated time en route
- Fuel on board in hours in minutes
- Alternate airports for landing
- Total number of persons on board including crew

Information submitted by a pilot through a VFR flight plan includes the following:

- Aircraft identification
- Aircraft type, special equipment
- TAS
- Departure airport identifier code
- Proposed departure time
- VFR Altitude

- Defined route of flight
- Destination airport identifier code
- Estimated time en route
- Fuel on board in hours and minutes
- Alternate airports for landing
- Total number of persons on board including crew

In addition, information is available to controllers from NAS weather processors. Global weather data provides information covering wide geographical areas (e.g., snow or thunderstorms moving through an area) that could limit or prevent approach to or departures from an airport. Also weather data specific to an airport is available (e.g., wind shear data or wind data) that could be used to notify approaching aircraft not to land or that could be used to change a runway configuration.

2.2.2 Information Obtained from the Pilot

Information required to be supplied by the pilot includes the following:

- Pilots instructed by ATC to follow another aircraft notify the controller if they lose sight of the aircraft being followed.
- Pilots notify the ATC controller any time a clearance is not fully understood, or is considered unsafe.
- Pilots who wish to make a "contact approach" receive a clearance for this approach from ATC (implies that the flight is operating clear of clouds, has at least one mile visibility, and can expect conditions to continue to the destination airport), and provides ATC immediate notification if pilot is unable to continue the contact approach.
- Pilots notify ATC anytime cruising airspeed varies plus or minus 5 percent, or 10 knots, whichever is greater, from that given in the flight plan.

- Pilots notify ATC of minimum fuel status when fuel supply has reached a point that no delay can be accepted upon reaching the final destination.

- Pilots inform controllers if aircraft being followed, or other traffic alerted to is in sight.

- Pilots notify ATC if they are performing a missed approach.

2.3 Functions

The following paragraphs describe in more detail the functions provided by the controller positions introduced in 2.1 and by the equipment that support the controllers. The operational flow diagrams associated with each paragraph illustrate the information flow between the controller and the user and between the controller and data processing equipment. The functions performed by the controllers are all covered by the requirements specified in the NASSRS. The pertinent NASSRS paragraphs that specify the functions being performed by the controller are referenced in each of the paragraphs below.

2.3.1 Functions of Position 6: Approach/Departure Controllers

Figure 2-3 illustrates all of the primary functions performed for approach and departure sequencing by an approach or departure controller and the information that flows to and from the controller. Approach controllers, at an ACF, sequence IFR and VFR aircraft approaching larger airports within a terminal control area (TCA) or airport radar service area (ARSA). The approach controller accepts a hand-off from the en route controller, and after directing the aircraft to the airport, transfers control of the aircraft to the local controller at the ATCT (where applicable). Departure controllers accept a transfer of control from the local controller after an IFR or VFR takeoff within an ARSA or TCA, and directs the aircraft to join its filed route of flight. (However, if an aircraft has taken off from an uncontrolled airport, but enters controlled airspace, then the departure controller is responsible for sequencing within the controlled airspace.) The departure controller hands-off the aircraft to the en route controller.

On an aircraft's approach to an airport, the approach controller accepts the hand-off from the en route controller. The approach controller provides the pilot vectors and instructions to direct the aircraft from the outer fix to the final runway approach. The approach controller may also

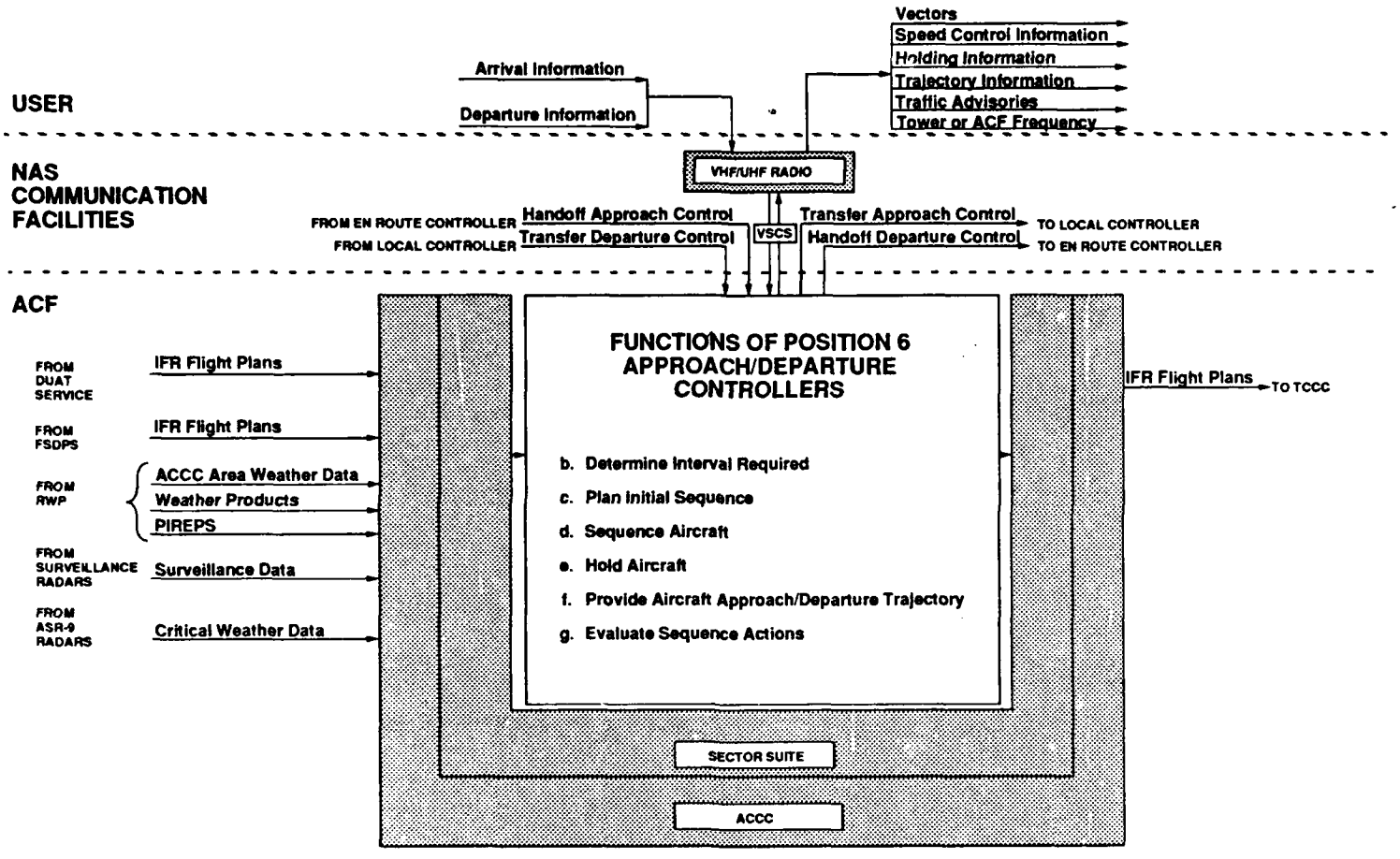

FIGURE 2-3

APPROACH/DEPARTURE CONTROLLER, POSITION 6: OPERATIONAL FLOW DIAGRAM

sequence the aircraft using STARs and altitude assignments. The approach controller sequences approaching aircraft based on various factors such as, aircraft speed, altitude, current heading, airport noise abatement procedures, and desired runway (if the pilot has a preference).

On an aircraft's departure from an airport, the departure controller accepts the hand-off from the local controller. The departure controller provides each aircraft the appropriate vectors, speed, and altitude based on the aircraft's final destination, traffic separation, and/or standard instrument departure (SID).

a. ACCC Processing. The ACCC provides automated assistance to the approach/departure controllers within the area of jurisdiction of the parent ACF. The ACCC processes flight plans, performs route processing, and provides position information. The approach/departure controller interfaces with the ACCC through a sector suite.

NASSRS requirement: 3.2.2.A
3.2.2.B
3.2.2.D.3
3.2.2.E

b. Determine Interval Required. The approach and departure controllers, with the assistance of the ACCC, determines the interval required between aircraft, the point at which it is to be accomplished, and the speed adjustments required.

NASSRS requirement: 3.2.2.C.1, 2, and 3

c. Plan Initial Sequence. The approach controller determines an initial sequence for aircraft approaching an airport based on aircraft position, speed, and altitude, as shown on the approach controller's display. After formulating the sequence, the approach controller establishes the aircraft sequence through some combination of vectoring, speed control, holding, and rerouting. The approach controller can direct an aircraft into a holding pattern in order to establish a sequencing pattern.

NASSRS requirement: 3.2.2.C.2

d. Sequence Aircraft. The approach/departure controllers sequences aircraft based on aircraft configuration, altitude, speed, required spacing, time and distance required to achieve heading changes, relative speed of aircraft preceding and

following, and the effect of wind on aircraft tracks, ground speeds, and turning distances.

NASSRS requirement: 3.2.2.C.2 and 3
3.2.2.E.1, 2, and 3

e. Hold Aircraft. The approach controller can direct an aircraft into a holding pattern in order to establish a sequencing pattern. Aircraft approaching an airport may be placed in a sequential holding pattern at a specific altitude. The approach controller may direct each aircraft in a holding pattern to descend as their turn to land progresses until the approach controller can vector the aircraft on a final approach to the runway. Also the approach controller can refuse permission for a VFR aircraft requesting entry to an ARSA due to traffic overload conditions.

NASSRS requirement: 3.2.2.C.1

f. Provide Aircraft Approach/Departure Trajectory. The approach controller with the support of the ACCC provides aircraft not following a STAR or instrument approach a final descent trajectory into the terminal airspace. The departure controller upon acceptance of control from the local controller and using the ACCC provides each aircraft not using a SID with a trajectory to direct the aircraft to join its filed flight plan route.

NASSRS requirement: 3.2.2.C.2
3.2.2.E

g. Evaluate Sequence Actions. The approach controller, with the support of the ACCC, evaluates sequence actions to determine if the desired sequence has been achieved and if any further actions are needed to correct or adjust the sequence.

NASSRS requirement: 3.2.2.C.4

3.2.2.E.1 and 2

2.3.2 Functions of Position 9: Local Controller

Figure 2-4 illustrates all of the sequencing functions performed by the local controller at the ATCT. Normally during both IFR and VFR departures, the local controller receives control from the ground controller, provides the aircraft departure instructions, and shortly after the aircraft has departed the runway, passes control to the

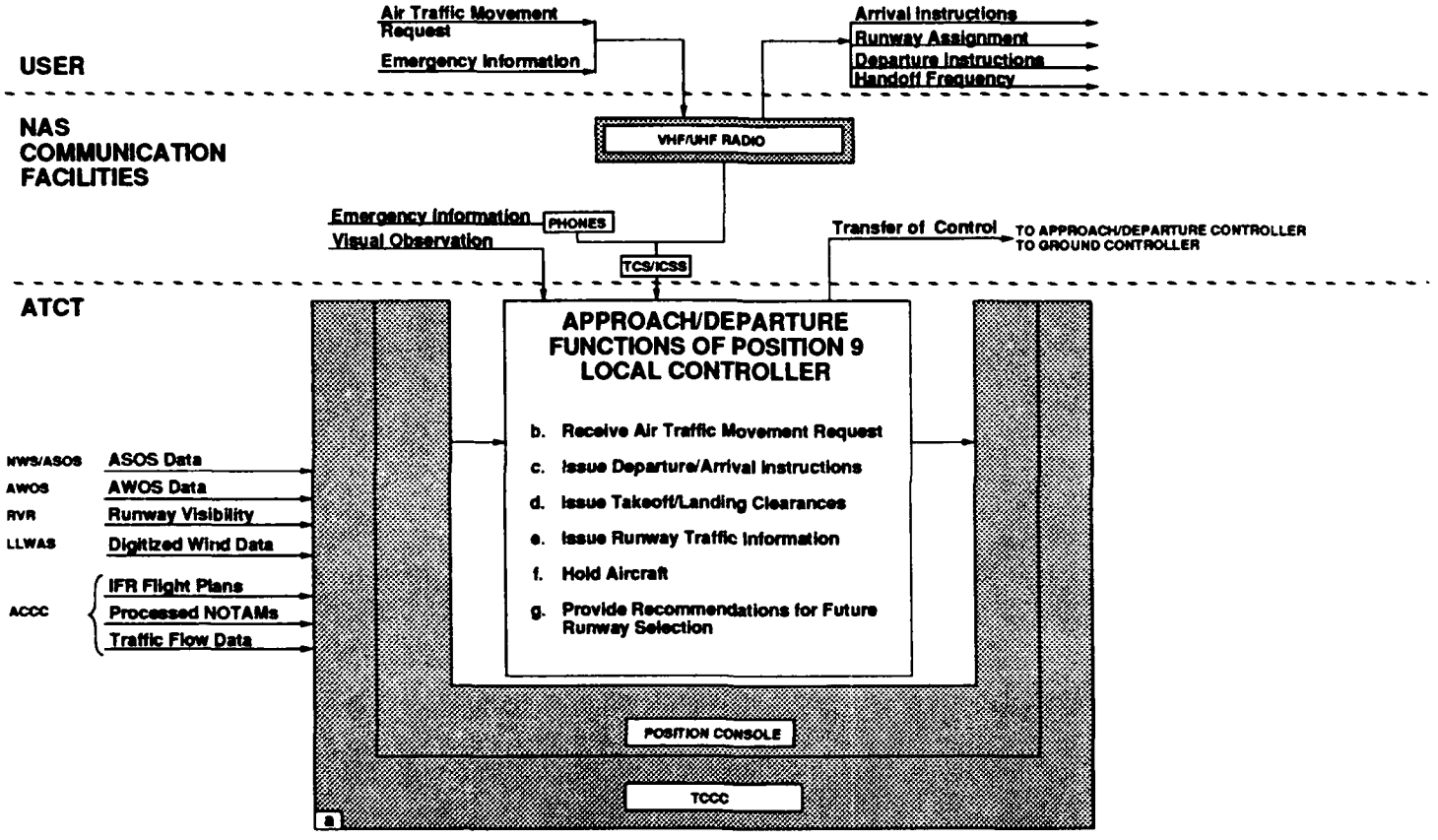

FIGURE 2-4

LOCAL CONTROLLER, POSITION 9: OPERATIONAL FLOW DIAGRAM

departure controller at the responsible ACF. Normally for IFR and VFR arrivals, the local controller receives a transfer of control from the approach controller located at the ACF, and issues landing instructions to the aircraft approaching the runway. At smaller airports, the local controller sequences approaching aircraft after receiving a transfer of control from the en route controller.

However, if the flight is VFR and entirely confined to the local controller's airspace, then the local controller has complete control over sequencing approaches.

a. TCCC Processing. The local controller accesses the TCCC through a position console. The TCCC maintains critical information required by the local controller such as, flight plan data, position data, weather conditions, airport, area, and equipment data, and graphic weather data. The local controller inputs departure or arrival times, airport acceptance rates, and runway configurations. Metering and sequencing information is passed between the ACCC and the TCCC.

NASSRS requirements: 3.2.2.A
3.2.2.B

b. Receive Air Traffic Movement Request. The local controller monitors the radio for air traffic movement requests from departing and arriving aircraft.

NASSRS requirements: 3.2.2.B
3.2.2.D.1

c. Issue Departure/Arrival Instructions. The local controller issues information/instructions to departing aircraft to taxi into position for takeoff, ensures that the runway is clear of obstructions, issues departure instructions, and issues takeoff clearances. During arrivals, the local controller ensures that the pilot has the current Automatic Terminal Information Service (ATIS) information, and then provides aircraft with specific traffic pattern instructions establishing aircraft spacing and sequencing (except if spacing and sequencing has been performed by approach control).

NASSRS requirement: 3.2.2.C.1
3.2.2.c.2
3.2.2.D.3
3.2.2.F

d. Issue Takeoff/Landing Clearances. The local controller issues the appropriate takeoff or landing clearance for each aircraft after ensuring that the runway surface is clear and that separation and wake turbulence avoidance standards are met.

NASSRS requirement: 3.2.2.B
3.2.2.C.2, 3, and 4
3.2.2.D.1
3.2.2.E.1, 2, and 3

e. Issue Runway Traffic Information. The local controller keeps the arriving aircraft informed of runway traffic information relevant to sequencing the aircraft approach.

NASSRS requirement: 3.2.2.F
3.2.2.G.1 and 2

f. Hold Aircraft. At smaller airports, the local controller performs approach sequencing. The local controller can direct an aircraft into a holding pattern in order to establish an approach sequence. Aircraft approaching an airport may be placed in a sequential holding pattern at a specific altitude. The local controller may direct each aircraft in a holding pattern to descend, as their turn to land progresses, until the local controller has vectored each aircraft on a final approach to the runway.

NASSRS requirement: 3.2.2.C.1

g. Provide Recommendations For Future Runway Selection. The local controller in consultation with the tower supervisor analyzes all available information that could affect the airport runway configuration, including traffic patterns, weather, and metering information. The local controller in consultation with the tower supervisor periodically determines the appropriate future runway configuration for the airport.

2.3.3 Functions of Position 10: Ground Controller

Figure 2-5 illustrates all of the primary approach and departure sequencing functions performed by the ground controller. During departures, the ground controller accepts transfer of control from the clearance delivery controller. The ground controller performs the primary

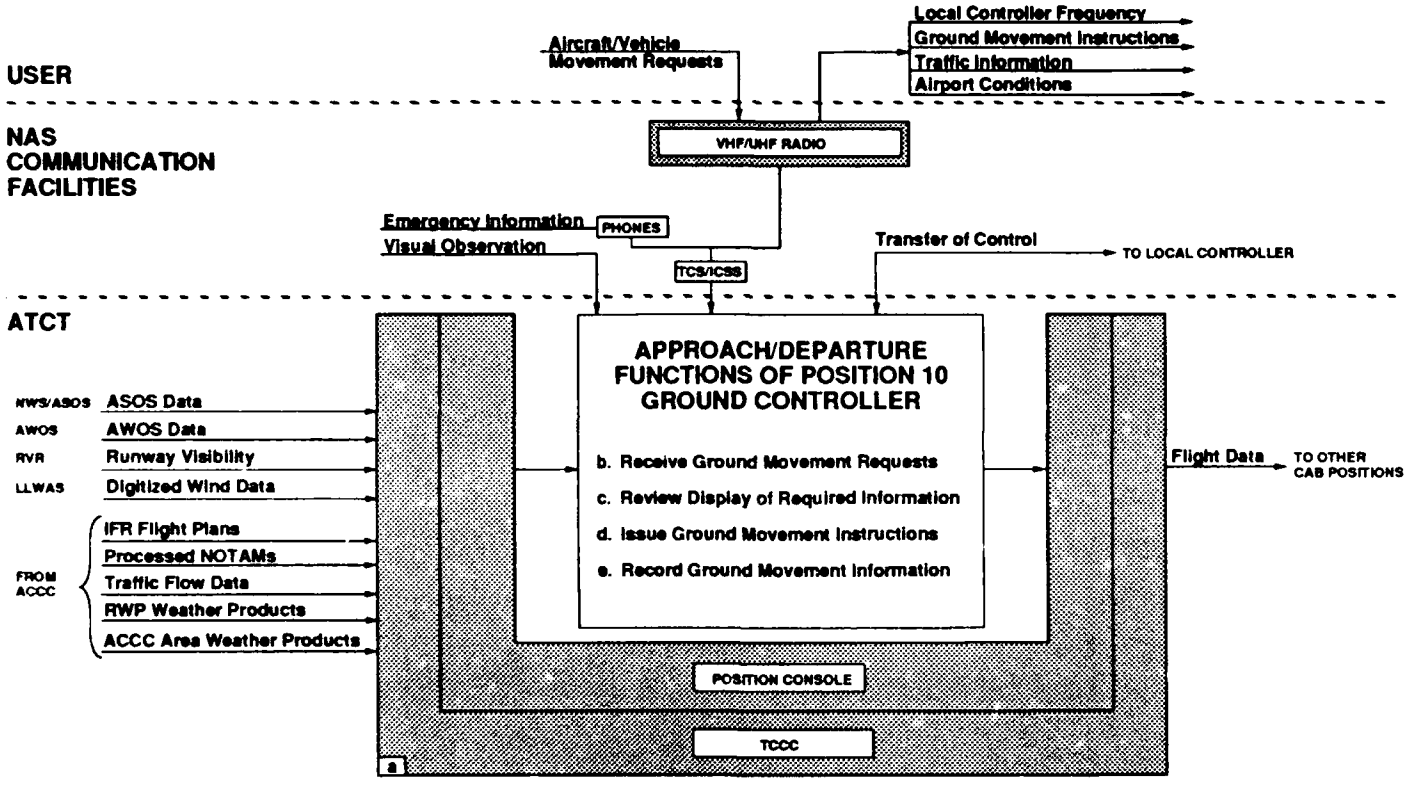

FIGURE 2-6

GROUND CONTROLLER, POSITION 10: OPERATIONAL FLOW DIAGRAM

departure sequencing function by directing each aircraft onto a taxiway leading to a departure runway, and then transfering control of the aircraft to the local controller. The order in which aircraft are in line to use the runway generally determines the departure sequence. Departure delays may be initiated by traffic management specialists. These departure delays, referred to as Estimated Departure Clearance Times (EDCTs), are processed by the ACCC and can change the departure sequence. Aircraft are sequenced for takeoff when they are in position on the airport taxiway leading to the departure runway. However, at some airports, the ground controllers have the flexibility to revise an aircraft sequence once the aircraft are lined up. For arrivals, the local controller transfers control to the ground controller.

a. TCCC Processing. The ground controller interfaces with the TCCC through a position console. The TCCC provides the controller information that is required to be available continuously such as: critical airport, equipment, weather data, and processed NOTAMS. EDCTs are processed by the ACCC and are passed to the ground controller through the TCCC.

NASSRS requirement: 3.2.2.A
3.2.2.B
3.2.2.D.2

b. Receive Ground Movement Requests. The ground controller monitors the radio for ground movement requests from aircraft parked in terminal areas.

NASSRS requirement: 3.2.2.B
3.2.2.D.1

c. Review Display of Required Information. The ground controller reviews the display of aircraft departures on the position console. The departure list contains a list of aircraft call signs for all aircraft proposed to depart within a specific number of minutes, ordered by proposed departure time.

NASSRS requirement: 3.2.2.D.2

d. Issue Ground Movement Instructions. The ground controller issues ground movement instructions to the aircraft. The ground controller directs the aircraft from the parking area through the airport to the taxiway leading onto the departure runway. The order of the aircraft along the taxiway normally determines

the sequence in which the local controller allows the aircraft to depart the airport, with the constraint that the local controller cannot allow an aircraft to depart before its EDCT. The ground controller directs arriving aircraft from the time it leaves the active runway to the parking area.

NASSRS requirement: 3.2.2.D.3

e. Record Ground Movement Information. The ground controller inputs to the TCCC information received directly from the pilot such as, changes to flight plans or flight data, or data observed, such as departure times.

NASSRS requirement: 3.2.2.D.3

2.3.4 Functions of Position 11: Clearance Delivery Controller

Figure 2-6 illustrates all of the primary departure sequencing functions performed by the clearance delivery controller and the information that flows to and from this controller. Prior to takeoff, IFR and VFR flight data received from flight plans and VFR departure information received from radio are entered into the ACCC. The ACCC processes flight clearances, and transmit the clearance or delay information to the TCCC. Flight clearances (or delay information when necessary) are displayed to the clearance delivery controller who reviews the information, and then transmits the clearance and instructions to the pilot.

a. TCCC Processing. The TCCC displays arrival and departure flight data clearance delivery lists at the clearance delivery controller's position console.

NASSRS requirement: 3.2.2.B
3.2.2.D.1

b. Review Clearance Requests. The clearance delivery controller reviews clearance requests displayed through the position console.

NASSRS requirement: 3.2.2.D.1 and 2

c. Transmit Clearances/Amendments/Instructions To Pilot. The clearance delivery controller transmits both VFR and IFR clearances to the pilot. The clearance delivery controller transmits delay information if clearances cannot be obtained.

NASSRS requirement: 3.2.2.D.3

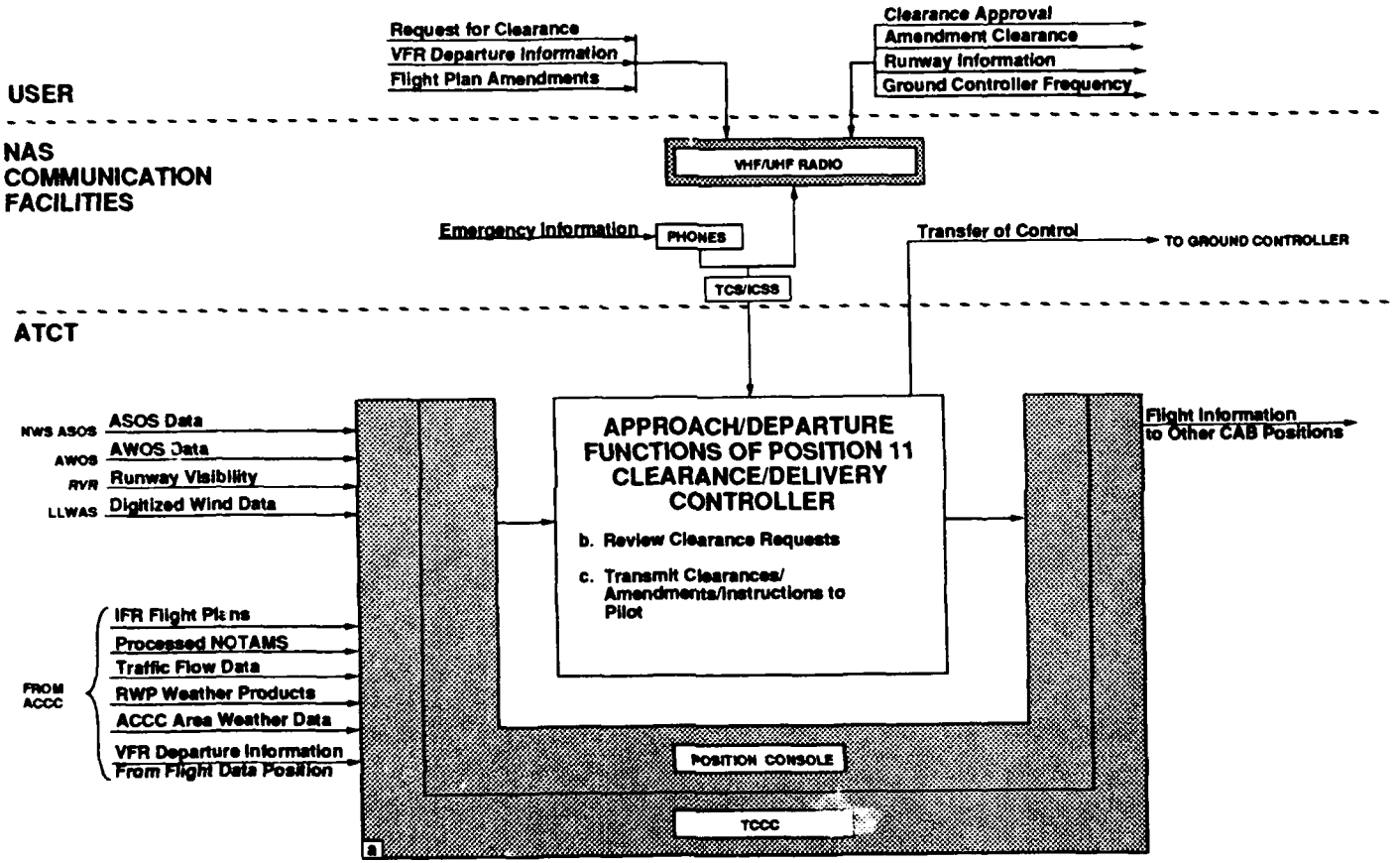

FIGURE 3-6

CLEARANCE/DELIVERY CONTROLLER, POSITION 11: OPERATIONAL FLOW DIAGRAM

2.4 Correlation With Operational Requirements

Table 2-1 summarizes the correlation of the approach and departure sequencing operational requirements paragraph of NAS-SR-1000 with the paragraphs describing the functions being performed by specialists/controllers. All the approach and departure sequencing paragraph numbers of NAS-SR-1000 are listed; paragraphs which are introductory in nature, do not state an explicit operational requirement, or which reference other portions of NAS-SR-1000 are indicated with a dash. The fact that a correlation is shown between a requirements paragraph and a paragraph describing the specialist/controller functions should not be construed as indicating that the requirement is completely fulfilled.

2.5 Operational Sequences

Figures 2-7 and 2-8 each illustrate a common sequencing of the functions described in section 2.3 and show how the various specialists interact with the user, other specialists, and NAS subsystems to provide the approach and departure sequencing service. Figure 2-7 shows a general sequence of operator/user interactions within the ACF and ATCT for arrival flow sequencing. Figure 2-8 shows a general sequence of operator/user interactions within the ACF and ATCT for departure flow sequencing. The numbers in the upper right hand corner of the action rectangles and upper vertices of the decision diamonds are reference numbers and progress more or less as time progresses during the operation. The cross hatching indicates an interaction with, and processing by, automatic data processing equipment (ACCC/TCCC).

2.5.1 Arrival Flow Sequencing Using Approach Control

Refer to Figure 2-7. Approach controllers at ACFs monitor radio frequencies for incoming aircraft (1). If the aircraft is VFR, the pilot contacts the approach controller requesting arrival instructions (2A). If the aircraft is IFR, then the approach controller accepts a hand-off from the en route controller (2B). The approach controller determines the desired sequence and required spacing for the aircraft with the support of the ACCC (3). Using the ACCC, the approach controller determines the required aircraft speed, spacing, and trajectory (altitude and direction) needed to properly sequence the approaching aircraft (4). The approach

TABLE 2-1
APPROACH/DEPARTURE SEQUENCING
OPERATIONAL REQUIREMENTS CORRELATION

NAS-SR-1000 Paragraph / Paragraph		Clearance Delivery Controller			Ground Controller					Local Controller							Approach/ Departure Controllers						
		2.3.2.a	2.3.2.b	2.3.2.c	2.3.3.a	2.3.3.b	2.3.3.c	2.3.3.d	2.3.3.e	2.3.4.a	2.3.4.b	2.3.4.c	2.3.4.d	2.3.4.e	2.3.4.f	2.3.4.g	2.3.5.a	2.3.5.b	2.3.5.c	2.3.5.d	2.3.5.e	2.3.5.f	2.3.5.g
3.2.2	General				X					X							X						
.A	Provide A/C Information				X					X							X						
.A.1	Unique A/C Identification				X					X							X						
.A.2	Position				X					X							X						
.A.3	Altitude				X					X							X						
.A.4	Course				X					X							X						
.A.5	Speed				X					X							X						
.A.6	Performance				X					X							X						
.B	A/G Voice/Data Communication		X			X					X			X			X						
.C	Issue Sequencing Advisories													X				X		X			
.C.1	Generate Advisories											X	X		X			X		X			
.C.2	Adjust Traffic Sequence											X		X	X			X	X	X	X	X	
.C.3	Respond to Inputs													X				X		X			
.C.4	Evaluate Alternate Clearance												X	X									X
.D	Process Departure Requests		X			X						X											
.D.1	Receive Requests		X	X		X					X				X								
.D.2	Display to Specialists			X	X		X			X													
.D.3	Provide Departure Information			X				X	X			X					X						
.E	Compare Flight Paths													X			X		X		X		
.E.1	Actual vs. Assigned Paths													X			X		X		X	X	
.E.2	Adjust Trajectory													X			X		X		X	X	
.E.3	Notify of Deviations													X			X		X		X		
.F	Recommend Current Runway Selection											X	X	X								X	
.G	Recommend Future Runways															X							
.G.1	Analyze Selection Information															X							
.G.2	Future Runway Configuration															X							

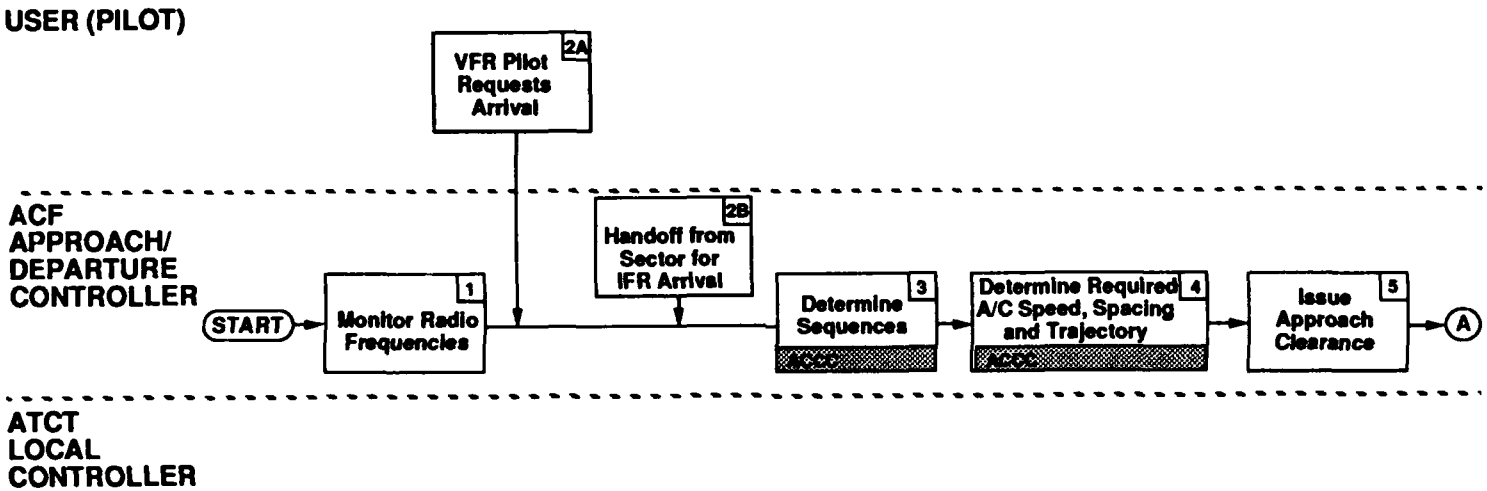

FIGURE 2-7

ARRIVAL FLOW SEQUENCING
OPERATIONAL SEQUENCE DIAGRAM

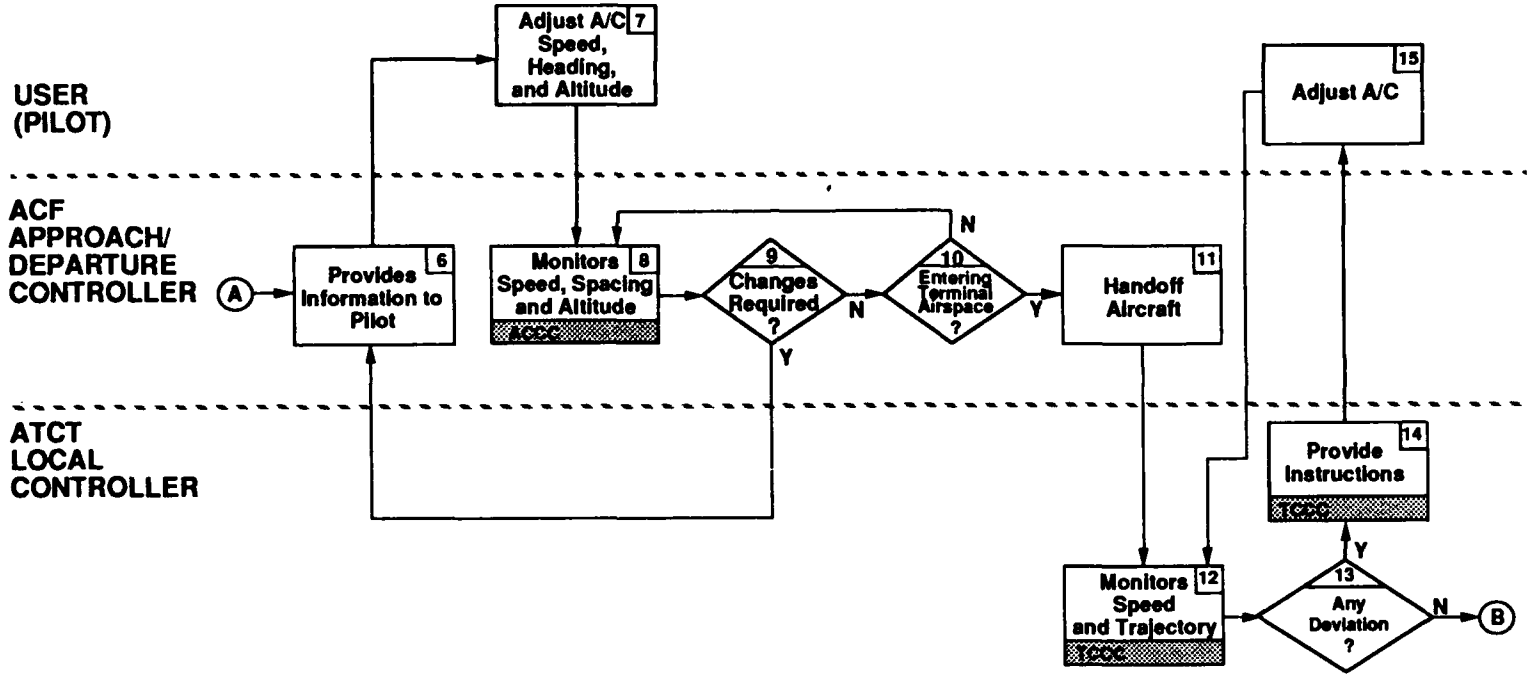

FIGURE 2-7

ARRIVAL FLOW SEQUENCING
OPERATIONAL SEQUENCE DIAGRAM
(CONTINUED)

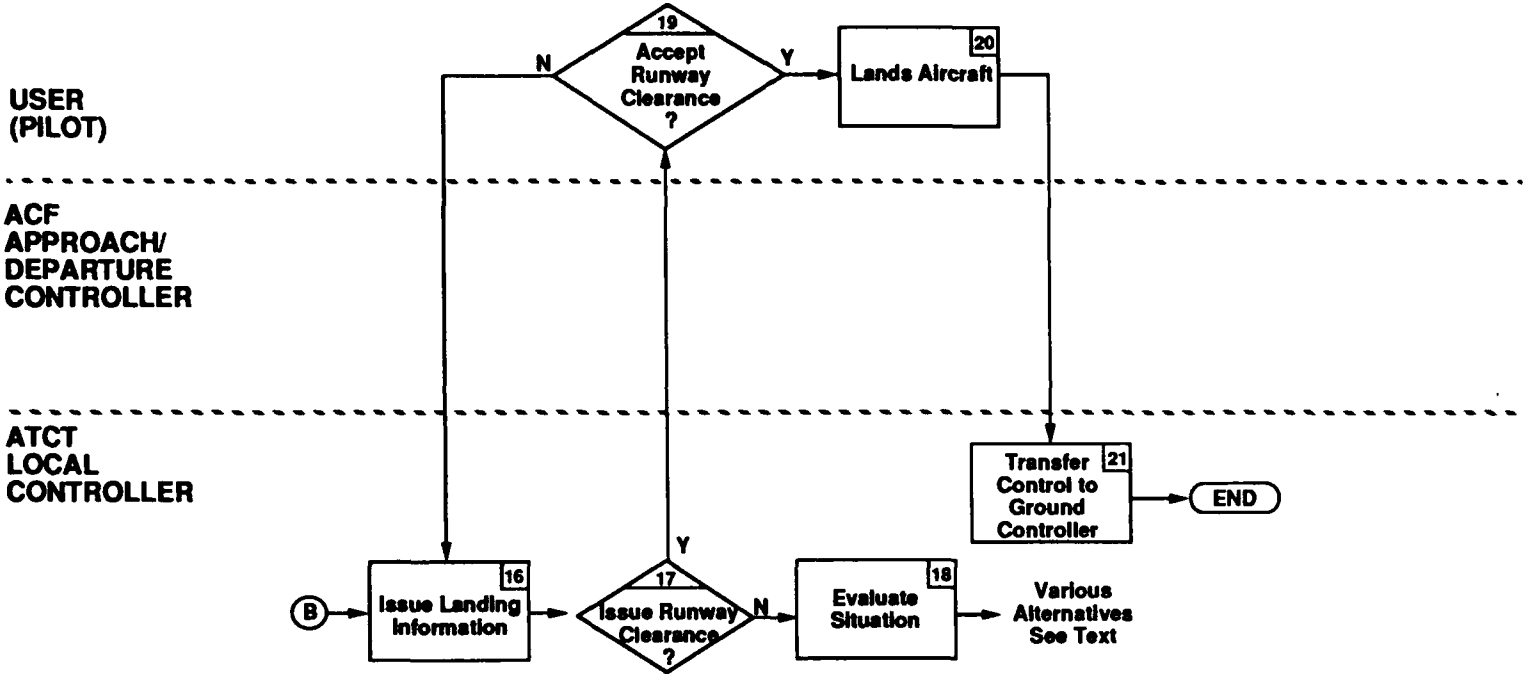

FIGURE 2-7

ARRIVAL FLOW SEQUENCING
OPERATIONAL SEQUENCE DIAGRAM
(CONCLUDED)

controller issues the approach clearance to the aircraft, (5) providing the aircraft pilot with the appropriate speed, spacing, and trajectory information (6). The pilot adjusts the aircraft's speed, heading, and altitude, as necessary (7). The approach controller then monitors the aircraft's progress (8), using the ACCC, to compare the actual flight path to the path assigned by the controller. If the ACCC notifies the controller that the aircraft has deviated from the assigned speed, spacing, and trajectory (9), then the controller again provides information to the pilot to adjust the speed, spacing, or trajectory (5), and steps (5) through (8) repeat. When the approach controller has determined that the aircraft is sequenced correctly, spaced safely with other aircraft, and on a proper trajectory towards the landing runway, the approach controller monitors the aircraft in preparation for hand-off to the local controller. Before the aircraft enters the local controller's airspace (10), the approach controller handsoff the aircraft to the ATCT local controller (11). The local controller uses the TCCC to monitor the aircraft's trajectory, comparing the actual flight path with the path assigned (12). If the TCCC notifies the controller that the aircraft has deviated from its assigned trajectory (13), then the local controller, with the support of the TCCC, provides additional instructions to the aircraft to adjust the aircraft trajectory (14). The pilot adjusts the aircraft speed and trajectory, as necessary (15). Steps (12) through (15) repeats until the aircraft is on a final approach to the runway. The local controller issues the aircraft landing information (16). With support from the TCCC, the local controller determines whether or not to issue the aircraft a runway clearance (17). If the local controller decides not to issue a runway clearance because of some condition (e.g., aircraft on the active runway), the controller evaluates the situation (18). Based on an evaluation of the situation, the controller may declare a missed approach and direct the aircraft to be resequenced for landing, or the local controller may determine that some other course of action is necessary due to airport conditions. If the local controller issues the runway clearance, then the pilot can accept the runway clearance or request a new clearance, (19). If the pilot accepts the runway clearance, the pilot lands the aircraft (20), and the local controller transfers control of the aircraft to the ground controller (21). If the pilot requests a new clearance because of a situation clearance that the pilot is aware of, then the local controller either issues a new clearance or provides further instructions depending on the immediate situation.

2.5.2 Arrival Flow Sequencing Using Local Control

Some airports are only tower controlled, that is, the local controller in the airport tower accepts hands-off directly from the en route controller at the ACF and sequences all aircraft approaching the airport. Approach/departure controllers at the ACFs do not control approaches or departures for these airports (which are generally smaller and with less traffic than ARSAs or TCAs). The operational sequence for a local controller sequencing arrival aircraft is essentially the same as in Figure 2-8, except that the local controller performs all the functions performed by the approach controller in Figure 2-7.

2.5.3 Departure Flow Sequencing

Refer to Figure 2-8. The pilot requests departure clearance (1). The ATCT clearance delivery controller processes the clearance request via the TCCC (2). When the departure request has been processed, the clearance delivery controller transfers control of the aircraft to the ATCT ground controller (3). The ground controller issues taxi instructions to the aircraft with the support of the TCCC (4). The sequence in which the ground controller lines the aircraft along the taxiway leading to the runway determines the aircraft departure sequence. When the aircraft are in sequence on the taxiway, the ground controller transfers control of the aircraft to the local controller for departure clearance (5). The local controller grants each aircraft clearance to depart maintaining a specific spacing between each aircraft in a specific departure sequence (6). The pilot maneuvers the aircraft onto the runway and takeoff (7). The ATCT local controller hands-off the aircraft to the ACF departure controller (8). The ACF departure controller monitors the appropriate radio frequencies (9). The pilot calls the departure controller (10). The departure controller provides each departing aircraft appropriate instructions necessary to direct the aircraft to its destination (11). The pilot adjusts the aircraft trajectory as necessary (12). With the support of the ACCC, the departure controller monitors the aircraft trajectory comparing the actual flight path to the assigned path (13). If the ACCC shows that the aircraft deviates from the assigned path (14), then the departure controller provides further trajectory instructions, with the help of the ACCC, to redirect the aircraft on its assigned trajectory (15). If the aircraft is flying IFR, the controller hands-off the aircraft to the en route controller when the departure controller ensures that the aircraft is on a proper trajectory and has left the terminal area (16).

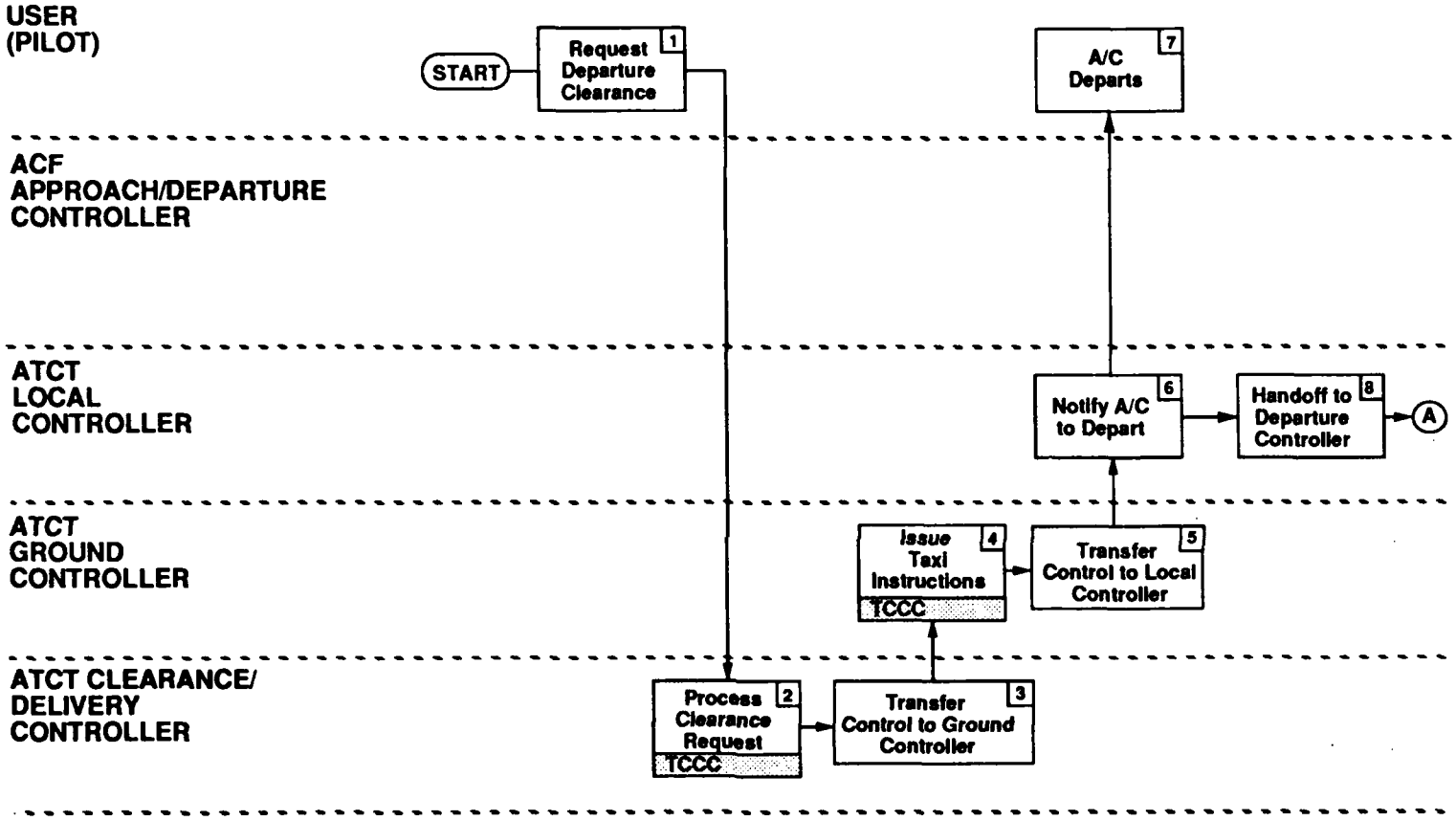

FIGURE 2-8
DEPARTURE FLOW SEQUENCING
OPERATIONAL SEQUENCE DIAGRAM

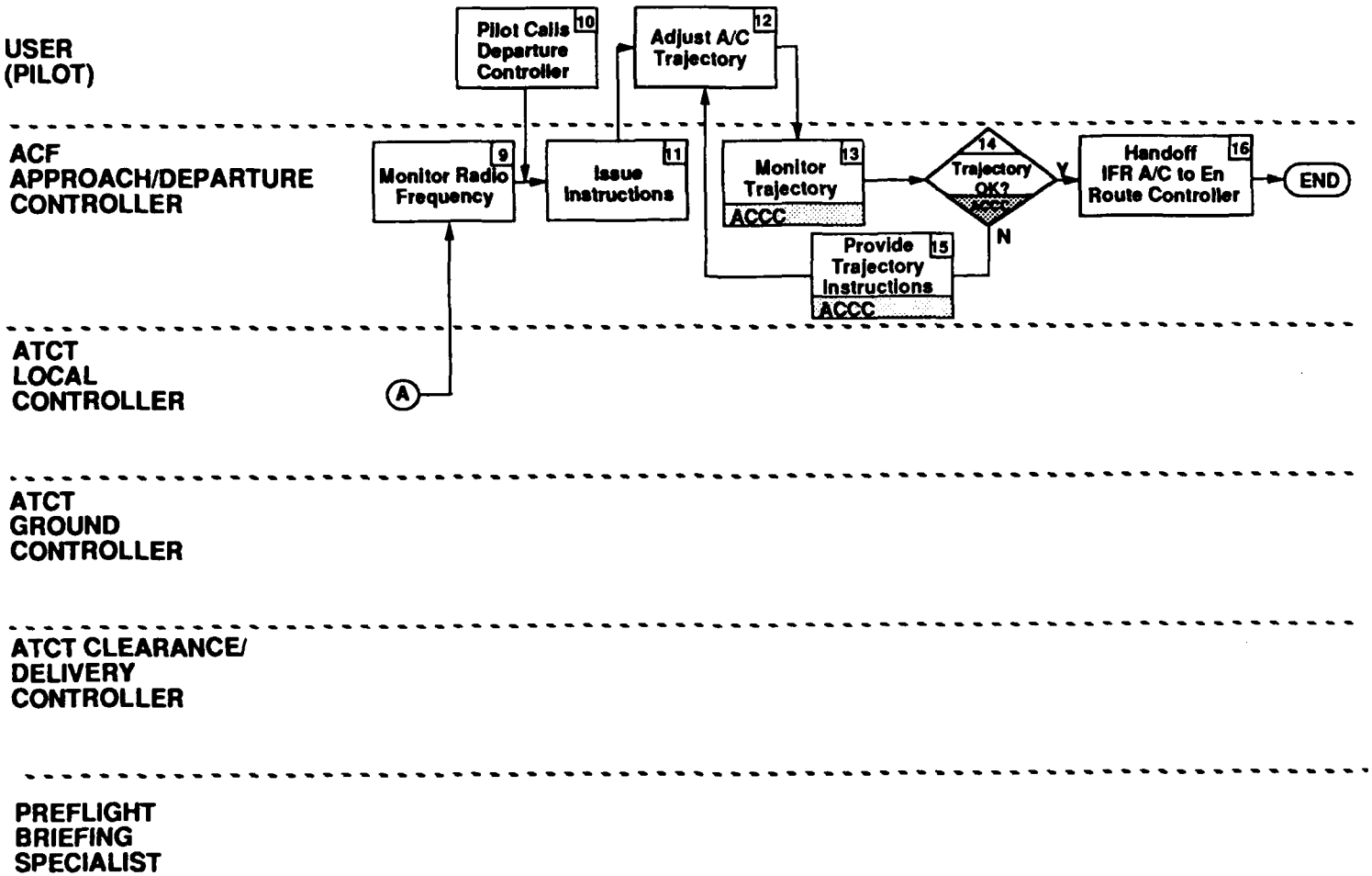

FIGURE 2-8
DEPARTURE FLOW SEQUENCING
OPERATIONAL SEQUENCE DIAGRAM
(CONCLUDED)

2.6 Operational Scenario

Figure 2-9 presents an operational sequence for a specific hypothetical situation (scenario). It is similar to the sequence diagram in Figures 2-7 and 2-8 in that it shows functional sequences and interactions between specialists and users and among specialists. The difference is that the operational scenario shows more detail and only shows one branch where a decision is made. The scenario described is approach sequencing between VFR and IFR aircraft in terminal airspace. Each row shows the actions of one of the participants and the numbers in the upper right hand corners of the action rectangles generally represents the sequence of their occurrence. The connections between rows illustrates the communications medium.

Figure 2-9 presents an approach scenario: Approach sequencing between a VFR and several IFR aircraft in an ARSA. A VFR aircraft contacts the approach controller (1). The ACF approach controller begins radio contact with the VFR aircraft (2) before the VFR aircraft enters the ARSA (3). The approach controller provides the VFR aircraft instructions to sequence the aircraft with IFR aircraft approaching the airport. The approach controller provides the aircraft with the appropriate vectors, speed, and altitude required to approach the airport in the proper sequence, and the runway assignment (4). The aircraft follows the approach controller instructions to the airport (5). The ACF approach controller monitors the VFR aircraft trajectory with the information provided through the ACCC (6). If the aircraft is on a proper trajectory and is within the terminal airspace, then the approach controller performs a hands-off to the local controller (7). The ATCT local controller begins radio contact with the VFR aircraft (8). The local controller provides the aircraft with landing instructions (9). The pilot approaches the airport following the local controller's instructions (10). The local controller monitors arriving aircraft through the position console display (11). When the local controller has checked the runway for obstructions and winds, the controller clears the arriving VFR aircraft for landing (12). The pilot lands the aircraft (13). The ATCT local controller transfers control to the ground controller in the ATCT (14). After landing and moving off the runway onto the taxiway, the pilot contacts the ground controller for further instructions (15). The ATCT ground controller directs the VFR aircraft to its final position for parking (16).

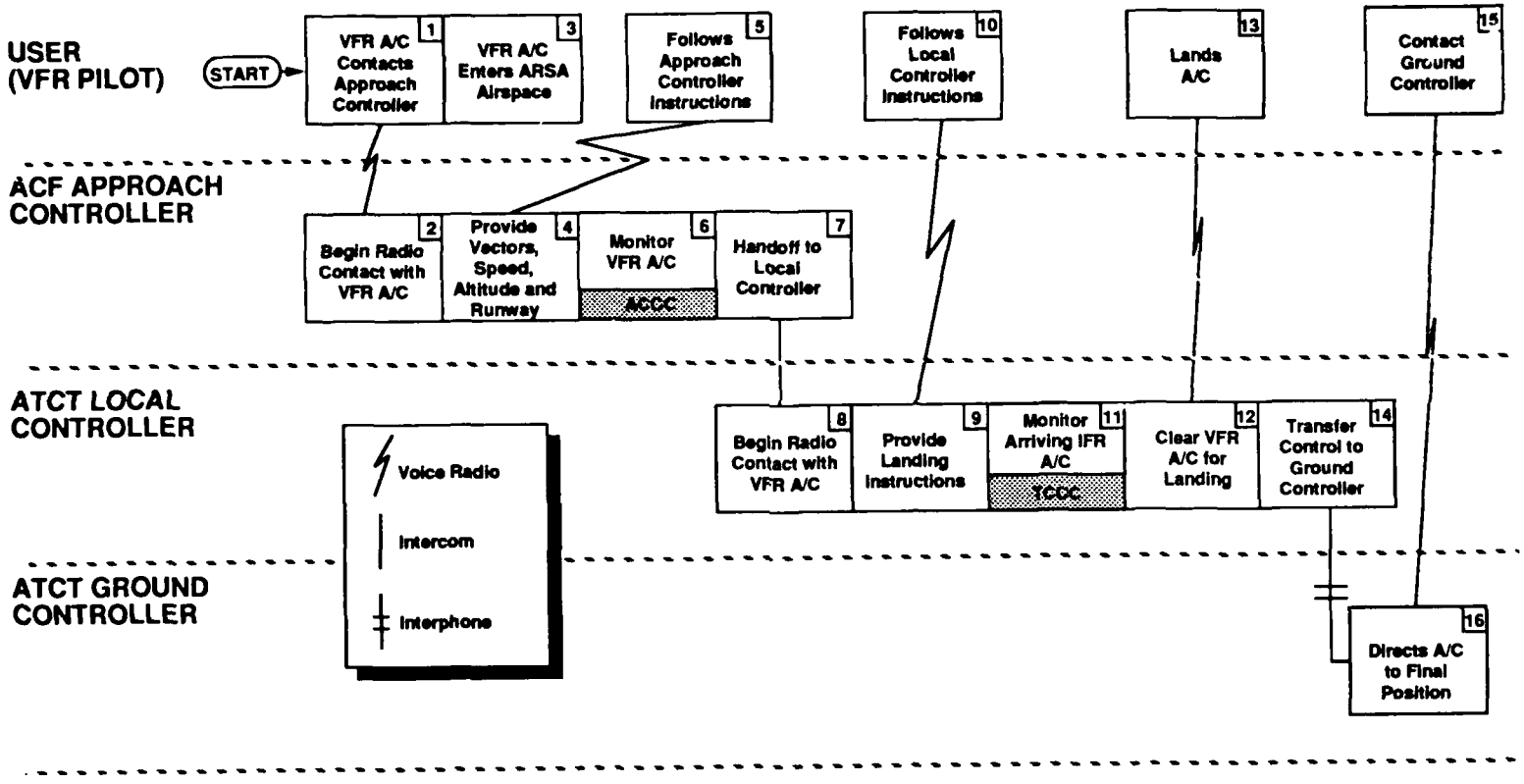

FIGURE 2-9

APPROACH SCENARIO: APPROACH SEQUENCING
BETWEEN VFR AND IFR AIRCRAFT IN
TERMINAL AIRSPACE

GLOSSARY

Acronyms

AAS	Advanced Automation System
A/C	Aircraft
ACARS	ARINC (or Automatic) Communications Addressing and Reporting System
ACCC	Area Control Computer Complex
ACF	Area Control Facility
ADO	Airline Dispatch Office
AERA	Automated En Route Air Traffic Control
AFSS	Automated Flight Service Station
APP	Approach
ARINC	Aeronautical Radio Incorporated
ARSA	Airport Radar Service Area
ARTCC	Air Route Traffic Control Center
ASOS	Automatic Weather Surface Observing System
ASR	Airport Surveillance Radar
ATC	Air Traffic Control
ATCCC	Air Traffic Control Command Center
ATCRBS	Air Traffic Control Radar Beacon System
ATCT	Airport Traffic Control Tower
ATIS	Automatic Terminal Information Service
AWOS	Automated Weather Observing System
CARF	Central Altitude Reservation Facility
DEP	Departure
DME	Distance Measuring Equipment
DUAT	Direct User Access Terminal
DVFR	Defense Visual Flight Rule
EDCT	Estimated Departure Clearance Time
FAA	Federal Aviation Administration
FSAS	Flight Service Automation System
FSDPS	Flight Service Data Processing System
FSS	Flight Service Station
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
INS	Inertial Navigation System
IVRS	Interim Voice Response System
LLWAS	Low-Level Windshear Alert System

MBO	Military Base Operations
Mode A	Basic ATCRBS
Mode C	Automatic Altitude Reporting Equipment
Mode S	Mode Select Beacon System
MLS	Microwave Landing System
NAS	National Airspace System
NASSRS	NAS System Requirements Specification
NOTAM	Notice To Airmen
NWS	National Weather Service
RCF	Radio Control Facility
RNAV	Area Navigation
RVR	Runway Visual Range
SID	Standard Instrument Departure
STAR	Standard Terminal Arrival Route
TACAN	Tactical Air Navigation
TAS	True Air Speed
TCA	Terminal Control Area
TCCC	Tower Control Computer Complex
TM	Traffic Management
TMC	Traffic Management Coordinator
TMF	Traffic Management Facility
TPC	TCCC Position Console
TRACON	Terminal Radar Approach Control Facility
TRSA	Terminal Radar Service Area
UHF	Ultra High Frequency
VFR	Visual Flight Rules
VHF	Very High Frequency
VOR	VHF Omni-directional Range

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